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## The Magazine

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# Caves.com

Exploring the "hard" side of Cave Digging, Cave Exploration and emerging techniques and equipment.

## Editor Contact Information

Mark Passerby  
[mark@caves.com](mailto:mark@caves.com)

Aaron Bird  
[aaron@caves.com](mailto:aaron@caves.com)

Rachel Bosch  
[rachel@caves.com](mailto:rachel@caves.com)

Ben Bird  
[ben@caves.com](mailto:ben@caves.com)

**Mailing Address:**  
P.O. Box 80693  
Lansing, MI 48908  
517-896-4376

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Most of the activities depicted herein carry a significant risk of personal injury or death. Caving, cavedigging and other underground activities are inherently dangerous. The owners of Caves.com do not recommend that anyone participate in these activities unless they are experts or have trained with qualified and knowledgeable individuals.

## Home Conversion Exhaust Kit for the Ryobi Gasoline Powered SDS Drill

Contributed by Bruce Zerr

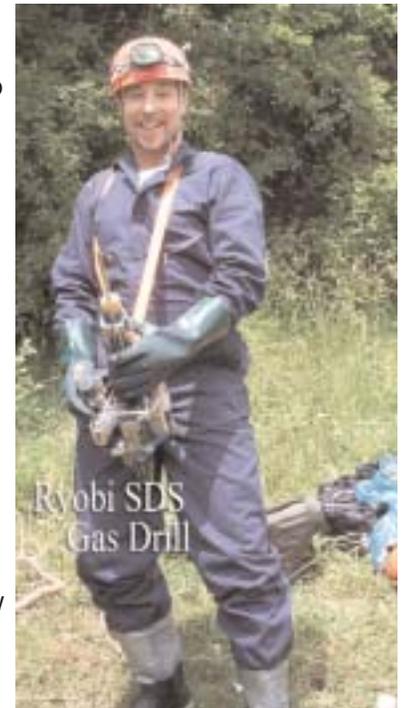
I modified my Ryobi Gas Powered SDS drill soon after I got it by changing the exhaust port. This allows you use your drill in tight or narrow cave passages where the exhaust fumes can steal your oxygen. This is not only a safety feature, but an inexpensive method to assist your cave digging needs.

The tools needed to modify the exhaust kit include the following:

- 1) 2 pieces of 2 1/2' x 5/8" flexible metal pipe
- 2) a 50' section of 5/8" or 3/4" plastic garden hose
- 3) brass fittings to connect the flexible metal pipe to the garden hose
- 4) brass fitting to connect the Ryobi exhaust port to the flexible metal pipe
- 5) Welder's Kit

The procedure:

Go down to your local appliance/hardware store and look for the flexible metal pipe that contractors use to hookup gas lines to gas hot water heaters. The pipe is 5/8" in diameter and should be gray in color, this comes in 2' and 2-1/2' lengths. Buy two pieces. After this is done, find a 50' section of 5/8" or 3/4" plastic garden hose. Next you will need the brass fittings necessary to connect your flexible metal pipe to your new garden hose. Lastly, you will need a brass fitting to have welded onto your Ryobi Drill exhaust port so that it becomes the new exhaust port. This brass fitting will also connect to the flexible metal pipe, so it must fit.



Miles Green tries on the Ryobi SDS drill.....

### In the cave:

When you take your Ryobi gas drill into a confined cave dig, bring along your two sections of flexible metal pipe and your garden hose. Connect one of the flexible metal pipes to the modified Ryobi exhaust port, connect the second metal pipe to the end of the first metal pipe, and then connect it to the garden hose. Fire up the drill. It will take some getting used to because the gray flexible metal pipe extends about 4 feet.

I would suggest that you wear dig gloves and a caving suit. Don't touch the flexible metal pipe once you fire up the Ryobi drill because it gets quite hot to touch. However, the two sections of flexible metal pipe will act as a heat exchanger and get rid of enough heat so that the garden hose can pipe it away without melting.

You do not need to go any longer than 50' for your garden hose because backpressure builds up. I found the end of the garden hose exhausts fumes at very high rate.

It is possible to use plastic garbage bags on the back end of the garden hose to collect the exhaust fumes as well. These fumes are not hot, but are lethal. You may need to upgrade your gasoline to a medium grade in order for this conversion to work properly.

# CaveDiggers.com

The End is Our Beginning

## Cave Finder

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**Cover Photo: Bob Kirk in  
cave sketching**

**John Ackerman with the "Cave Finder"**

## *Interview with John Ackerrman July, 2003*

Aaron: John, please tell us how you got into cave digging in Minnesota?

John: O.K. Well that's a good question. I guess the reason why I got into cave digging in Minnesota is because there are very few caves that have been discovered in this area. So really, cave digging became a necessity to find caves.

Aaron: How many caves did Minnesota have naturally before people started digging?

John: Well, you know, even though we may have thousands and thousands of sinkholes, we have very few caves that are known, documented, and surveyed. I would guess that realistically you could count them on one hand. So the caves that are suitable for visitation are maybe two or three. Not to say that we don't have some significant caves in this state but what we do lack are cavers. We have very few cave explorers in this state, but on the positive side we have very many sinkholes that are waiting to be excavated because that's where you're going to find your caves.

Aaron: Was Spring Valley Caverns an open cave before you got involved with it?

John: Spring Valley Caverns was discovered by a young farmer who had just purchased a large farm in southeast Minnesota. He was out looking for a calf on horseback one spring morning after a heavy rain and found that a sinkhole had formed on the edge of a ravine. Subsequently he entered the cave with his wife and two little kids and thought it was so spectacular that it needed to be commercialized. So he ended up commercializing this cave which was about a half a mile long in the late 1960's and that commercialization effort failed after one or two seasons.

That cave sat empty until I came

around, which was about 1987. By then the land had changed owners three or four times and the current owner had invited me out to this property, not only to visit this cave once again because he was naturally curious, but to also determine if any other caves could be found in one of forty-five or fifty sinkholes on his property. So I ended up buying roughly half the farm from him back then and expanded Spring Valley Caverns from a half a mile to over five and a half miles.

Aaron: Was that all from one entrance or did you dig open other entrances?

John: I found over five miles by sticking to one project within the cave for almost a year. We had all the right "cave signs" and up here when you want to find a cave it's not like ridgewalking and finding a deep pit and just rappelling down. This is called "Persistence" with a capital P. So my partner and I spent about a year opening, enlarging a crevice and found mostly all of it just after one breakthrough. There were other small breakthroughs in the cave after that, none of which required any rock removal, maybe a small amount of sediment removal, but we actually found large walking passages, large rooms. Most of the new find is 70% walking. So it was an exciting time. That was in about 1990.

Aaron: Have the caves in Minnesota traditionally been developed in the water table or do they have streams flowing through them?

John: To find a cave in this state, you'll need to dig in a sinkhole. Typically when we excavate a sinkhole, we find that the cave typically allows us to enter it about fourteen feet down from the bottom of the sinkhole. From there it usually brings us into the main level in the Dubuque Formation, which is probably forty to sixty feet below the surface of the land. From there we typically find ourselves at the contact zone between the Dubuque Formation and the Stewartville [member of the Galena Formation].

The Stewartville will lead you effectively down to the water table because that's about as low as you will go. You'll usually find a stream or a river at that level and so, in most of my seventeen caves that I've discovered on my property, you will find a river or stream passage down below them.

Aaron: What age are these rocks?

John: 400 - 600 million years old. Ordovician aged.

Aaron: Are there formations in these caves?

John: Oh yeah, we have one formation that was found recently that's considered the largest column in this state. It's so big that two or three people could not get their arms around it and it's probably twelve feet tall. It's an amazing column. We call it the Leaning Tower. But yes, we have a multitude of formations just like any other state does.

Aaron: You said seventeen caves on your property?

John: Well, we're working on our eighteenth cave now.

Aaron: That's great. How long are these caves that you've found on your property?

John: Like I said, the breakthrough at Spring Valley Caverns has brought us to over five and a half miles. I have another cave that I discovered on my property that's over half a mile long; another one that's not too far behind that one; and then the rest of them all are less than, I'd say, 1000 feet. Somewhere in there.

Aaron: Are they related hydrologically?

John: You know, we haven't done a lot of dye tracing yet, but I believe that they probably are. They're scattered in about a mile diameter area on my property. They each have

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their own special characteristic. Some of them have unique features that others don't. But probably the same water courses through most of them.

Aaron: You've been involved with caving in other states as well in the Midwest. What are some other areas you've been involved in?

John: I've traveled around the United States and gone caving virtually everywhere. I've been to Cheve Cave in Mexico. Once in while, when time permits, I'll go out to the Black Hills and go wild caving, and so I've traveled all over and cave all over, but stuck around close to home here primarily because we have caves that are so close. I'm an hour and a half away from the caves here in this state.

Aaron: Are there any special tools you guys have used in digging open these sinkholes?

John: Well, we're hard core diggers. Let's put it that way.

Aaron: Heavy equipment...?

John: Yeah, we do anything...we do whatever it takes. Back in the early 1980's it was very apparent that we were not going to get anywhere unless we could open up sinkholes. Even when you're in a cave, it's pretty apparent that if you want to find going passages, even if you have airflow and other signs, if you don't have the right digging equipment, you're not going to do it. So really what we're looking for are "cave signs," and if we can get the proper cave signs, the rest is just a matter of removing the fill or widening passages that are inaccessible. So yes, we've got our special hand tools, and drag boxes and all kinds of goodies that we use.

Aaron: What do you look for in "cave signs?"

John: Up here, I'm sure it's the same as in other states. We want to spend some time where we're feeling wind movement. Another thing

that may be unique up here is we're looking for little white dots. When we dig in sinkholes, we have a fairly reasonable expectation of finding a cave because that's why the sinkhole is there, but if we can uncover just one rock with little white dots on the back, we call it condensation corrosion, we know there's air movement down there, and then we're just going to pursue it with a vengeance.

Aaron: That's funny. I've seen that before and I've made a rough association, but now that you mention it, I agree, the white dots probably do indicate at least condensation if not air flow as well.

John: In the southern part of this state, we found that it really points to air movement.

Aaron: Yeah, I've seen that before also. Have you been involved with the Coldwater Cave activities of late? Is that something that you can talk about now?

John: I've discovered and explored other caves on southeastern Minnesota, and I've typically spent the bulk of my time right on my own property because the caves don't get any better than that. We have caves like anybody else. We have rivers. We have hundred foot tall pits and passages. We have lots of mud, too. Most of the caves are dry. So, we have a lot of exciting things happening in our caves, but I've been involved with other projects and the most recent project that has diverted some of my attention away from the Cave Farm has been Coldwater Cave.

Cold Water Cave is located right across the Minnesota border, which is probably thirty-forty minutes away from my farm. As you probably know,



Coldwater Cave was discovered in 1968 by cave divers and the State paid to bore a hole into the cave. They leased the property from a local landowner who happened to own the property right about above the main trunk line, but the state of Iowa was unsuccessful in obtaining enough money to commercialize this cave, so they turned the shaft and the small building back over to the landowner, after three years. Since then, this cave has been controlled by just a few key holders and access was not what it could have been, so about eight years ago I embarked on a campaign to create my own entrance into this cave and after many hard fought years, I was able to obtain 205 acres of that cave, so I have recently sunk a 30 inch diameter shaft into one of the side passages 188 feet down.



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Aaron: Wow. That's a pretty significant hole to dig.

John: It's a very large hole. There are a lot of similarities between it and Carroll Cave in Missouri. They had twelve miles of passage and drilled down about 118 feet, took about a year of blasting. That cave was also declared a National Natural Landmark. Coldwater Cave is a sixteen mile long cave. It's the 33rd longest in the United States. We were able to drill down 188 feet in just a couple of months. It was a very quick project.

Aaron: How was it so quick?

John: It was quick as far as drilling. Like I said, it was in the planning for eight years. It took a team of attorneys to move forward with this thing because, obviously, we expected some resistance, but once we got the drill rigs out there, it went relatively fast. We were supposed to have this shaft drilled in about a week and a half. It took two full months because the well rigs kept breaking down due to the extreme density of the rock.

Aaron: Is that the same kind of rock that's in Minnesota on the Cave Farm?

John: Yeah, or even harder. It drops a few rock layers [into the lower Galena] as you go south, so it was very brittle, very hard rock, quite unexpected from the drilling company's standpoint.

Aaron: What diameter holes were drilled?

John: Thirty inch diameter.

Aaron: With one drill?

John: Well actually, because I didn't want any contamination going into the cave, I requested that they drill a fifteen inch hole all the way down until ten feet above the cave ceiling. They had to case the first twenty feet. Then when they reached that depth, they pulled out the fifteen inch casing and used a completely differ-

ent rig. By the way, there were four different drill rigs that it took to accomplish this. Another rig came in and installed a thirty inch steel casing. From there, they went down, utilizing a fifteen inch, twenty-four inch, and thirty inch bit all in one. They coupled them all together and went down through this fifteen inch hole until they were ten feet above the cave ceiling. Then they continued downward using this triple bit system. It was remarkable in the sense that it put very little slurry or what we call "findings" down into the cave passage.

Aaron: Wow. That is really amazing.

John: So we have recently installed a 188 foot ladder as a temporary measure to get up and down.

Aaron: Still a pretty tight hole, though, isn't it?

John: Well, thirty inches is optimal. That's the size that the State originally drilled at the other entrance, and that's the size I've chosen for all the entrances at the Cave Farm. Its small enough that you can be comfortable leaning against the side with your back, if you're tired, and large enough for the larger cavers.

Aaron: How high is the passage? Was the height of the passage a reason why you didn't want the spoil, or "findings," down in the cave?

John: The original entrance that the government created was right smack dab in the middle of the main river borehole passage. It is quite unsightly. They have a large dock system right above the water. I chose to create my entrance in a side passage away from the river passage, and not only that, we were able to create an entrance that skimmed right along the edge of the side passage, so it was very unobtrusive to the cave.

Aaron: Was that made possible because of exploratory drilling, or because of the accuracy of the survey?

John: We have a copy of the original survey, which we utilized for this project, but before we began our main drilling, we hired a separate firm to come and drill a test hole. It was a five and one-quarter inch test hole, which was very successful. Then we lowered a camera down the test hole and determined that there were some minor formations in the way, so we located the main shaft about fifteen feet away from them.

Aaron: That's great. So what are the current activities in the cave now?

John: You know, nobody from our group has been more than two or three hundred feet from the entrance because we've been spending our time making a lid and installing the ladder system. Like we talked about, most of our time is spent at the Cave Farm, so I haven't had a lot of time to devote to this project, but we have come a long way. We have a secure entrance now with a very nice, stable ladder, so we're ready to go.

Aaron: What is the potential for Coldwater Cave? Right now it's at 16 miles, I think you said, so is there potential for more cave there?

John: Well, I'm a caver, and primarily what I'm into is cave exploration, so that's where I focus most of my activities, and yes I feel there's potential for many more miles in this particular cave. It's a spectacular cave by the way.

Aaron: I believe I remember reading the NSS article... oh, maybe ten years ago, or more... and I remember being very impressed and excited by it.

John: Yep. We're starting to work on another project nearby in Minnesota where there is known to be a cave system probably three times as large as the Coldwater Cave system, and we know that based on dye tracing. The largest blind valley in the state

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is located between Coldwater Cave and the Cave Farm, and as yet, nobody has been able to gain access to it, primarily because there are very few cave explorers up here, so we're moving ahead with that project now.

Aaron: Wow, that's sounds exciting. Now, the Cave Farm caves... do they have their own hydrologic system that's unrelated to Coldwater and the new area you mentioned?

John: Totally unrelated.

Aaron: So these are three separate hydrologic systems.

John: Yes, totally three separate systems.

Aaron: What are the current activities on the Cave Farm?

John: Well, right now we're hoping to open our eighteenth cave. Last year was the first year we were able to utilize what we refer to as the "Cave Finder," which is our nickname for an excavator. In the past I have hired out contractors - a local construction company- to help out with back-hoeing, and finally we just made the decision to purchase the excavator ourselves. I was able to find a 1996 CAT 312 Excavator in Utah, and had it shipped to Wisconsin, where I had the stick and the boom extended so it will easily dig 25-feet down. [Aaron chuckling in surprise] It's a very, very good tool.

Aaron: [Still chuckling] That's great! How many caves has that thing gotten you into?

John: We found a couple last year using it, and I suspect we'll find many more. It sure beats the old bucket and pulley system with wood shoring.

Aaron: I bet it does. Heavy equipment is the way to go, if you can get a hold of that stuff. Well what is the total potential of the Cave Farm?

John: I just keep purchasing more land as I can. Land is getting pretty scarce because Rochester, Minnesota, which is the home of IBM and the Mayo Clinic, is just mushrooming out. People are looking for hobby farms and so land is being gobbled up, and I've been lucky enough to expand the Cave Farm to 325 acres. I also own over 200 acres of underground rights beyond this property, but I would like to continue purchasing property, if and when I can. I would suspect there are at least 15 more caves left to be discovered on my farm based on the amount of sinkholes. I have no doubt that will continue to become a reality if we continue to do what we're doing.

Aaron: O.K., let me get this straight: you have 17 caves, and an 18th on the way. Do these each have their own entrance?

John: Yes, after I excavate a sinkhole and locate the cave entrance, it is usually necessary to create a



more suitable artificial entrance into the cave. The problem with allowing the sinkhole to become your permanent entrance is the fact that the cave will become flooded with copious amounts of mud and water that will drain down into the sinkhole

entrance, making it very unstable and unsafe to keep such an entrance.

I have a cave radio that we use to find a suitable man-made entrance site, and we create that entrance and after we're done creating the man-made entrance, we permanently close the sinkhole by using rebar and concrete and crushed rock. We really insist on restoring the sinkhole and surrounding ground to the original condition before found it... or even better.

I know there are parts of the United States where if a sinkhole is opened up and a cave is found, that may be a suitable entrance due to the different rock strata. You might not have the problem with copious amounts of run-off from the nearby farm fields down into the cave, but here that's not a possibility because the sinkholes act as underground water conduits, we really need to create an entrance that is high and dry.

Aaron: What are the characteristics of your permanent entrances?

John: Well, we utilize 30-inch culverts. For the most part, I purchase culverts with a rubber membrane so they will last indefinitely. Usually those culverts are thicker gauge steel than the average road culvert. We'll pick a spot with cave radio where it won't damage the cave environment, and then typically what I do is pull away all the soil and, kind of similar to what they did in Carroll Cave, I drill thin diameter holes in a 30-inch diameter circle and just work my way right down into the cave ceiling. Typically we use a 200-grain det cord, and just create our own way down. When we're down inside the cave, we remove any rock shards that may have fallen down into the cave, and after that procedure we install the culvert right on top of the bedrock. We'll backfill the whole area, and then we'll put on a special lid we make that has safety releases from the inside in case someone decides to play a little joke

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on you while you're inside the cave. Then we'll restore and seed the area around the work site and few months later, you'll walk by and never know that anything have ever been done there. There'll just be a two-foot high culvert sticking out of the ground with a lid on it.

Aaron: And you have 17 of these around the cave farm?

John: Yes.

Aaron: Wow!

John: For the most part it's a heavily wooded, rolling area, so it's somewhat difficult to detect these man-made entrances.

Aaron: Do some of the caves connect together?

John: A couple of them come pretty damn close, but for the most part they're spread out pretty far away from each other. It seems as though what we're finding is that if a person is very persistent in this part of the country, if you dig out a sinkhole, you will find a cave. The theory is that the sinkhole was caused by the collapse of a large cave passage that may be intersected by another cave passage, and so that's where we're going to the find the caves.

When you travel further south towards Iowa, you'll find that the sinkholes are poised directly over tall domes, perhaps over 100 to 150' tall, so you get quite a surprise when you open up one of those sinkholes and hear the rocks falling 150'.

Aaron: This is all really impressive. Now I do want to ask the question about how you got into this... because I'm not aware of anyone else who has done this type of work...

John: You know, I'm not sure how I got into it; I've always been caving. I have fond memories of roaring through the St. Paul mines late at night on my motorcycle with a 12-pack strapped onto the back and my girlfriend's breasts pressed tightly against my back. [Aaron and John

laughing]

That was in about 1971 or 1972, and shortly after that I actually cut off my pony tail and went through college and got a degree in law enforcement. After a short stint in that, I realized that I couldn't handle being broke all of my life, so I became self employed, and that'll bring us right up to the present.

Aaron: So it's a life-long activity then.

John: I don't really know where it all started, but as a little boy I just remember being fascinated by caves, and I've visited caves all over the United States and to this day can't lose the bug. I think it's just a hobby that got out of control.

Aaron: Well, I think it's done that for a lot of people.

John: It's almost a religious experience when you find a new cavern and stroll through it for miles. It truly is. It is an unbelievably overwhelming feeling that most of us in this small club have had a chance to experience. I guess along with that comes the responsibility of making sure that the discovery gets protected.

Aaron: That's a good approach. Does Minnesota have cave protection laws?

John: They do not. And they do not have what we refer to as a sportsman's law, which will guarantee that the landowner will not lose everything if somebody that he has invited onto his property has a serious accident. So our insurance in the upper Midwest has tripled in one year. For instance my own carrier canceled my policy last year for no reason, other than they chose to get out of the cave-liability policy, which forced me to search for insurance, and the agency I was with opened it up for bidding. Three insurance companies across the United States responded and in the end only one would entertain a bid. Subsequently the insurance premiums tripled in one year and I've been warned that perhaps

in a year or two, that particular carrier may not even want to become involved in cave-liability insurance. This is affecting a couple of the local commercial caves: one in Wisconsin and one in south-eastern Minnesota and they're very, very concerned and worried about this.

Aaron: Do the caves of Minnesota have any endangered species of animals, plants, fungus anything?

John: Not to my knowledge. We have four species of bats, and like everywhere bats are practically endangered. We're worried about they're declining numbers. I took great pains to design our main cave building (which rests over the top of the main entrance into Spring Valley Caverns) to incorporate a bat-accessible entry. There are some rare plants on some of the cliff faces near the cave entrances, but really there are no endangered species that I'm aware of that inhabit these caves.

Aaron: So there's no motivation in the State government to make any changes in the way that they treat the caves right now.

John: No, not at all.

Aaron: Is there any motivation [by the State or landowners] to fill them in? Perhaps to remove liability?

John: You know, the DNR has been in the habit of obtaining caves and protecting them. I would doubt that they would purposefully seal any of the sinkholes or caves, if they were known. In the Twin Cities, we have quite a few areas that have been mined out as storage facilities. Those have been backfilled and some of them have been heavily gated due to liability concerns.

Aaron: The insurance and liability issue sounds a very perplexing problem for you.

John: It's a problem. I was very happy to find out that my insurance

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carrier picked up the Coldwater property and combined it with my Cave Farm policy with only a \$300 increase. That was a very pleasant surprise, but I don't anticipate that is going to last forever.

Aaron: So a liability release doesn't have any weight does it?

John: No, not really, although the insurance carriers have requested that anyone who visits my farm sign a liability release, the theory being that it may help somewhat, though they said in the end it never has.

Aaron: You have a little more controlled situation on your property: you know who is coming and going and those people are your friends, and they're not going to sue you, right?

John: That's correct. The property is well gated and anyone who has access is well known to the caving community. We do have visitation from the University of Minnesota and some of the local nature groups, and of course the local caving community.

Aaron: So the worst case scenario, it sounds to me, is that you would have to more tightly control access, if the insurance carriers decided it was too much liability for them, and then you would have to hope no one would sue you...

John: That's about it. Eight years ago there was a major scare in south-eastern Minnesota. The insurance companies were actually warning landowners not to allow cavers onto their property, especially to dig in sinkholes, due to the liability situation. For a while it was a tough sell for us to explore private property in that part of the state.

Aaron: Has this reason been a big a motivator for you to buy your own property and work on your own property?

John: Not necessarily, I would say it seemed as though the more time I spent on this particular farm, the

more I became ingrained in the possibilities. After you start opening cave after cave with no end in sight, it just kind of takes hold of you. The landowner [original] was a very gracious individual, and he was as curious about what was underneath his farm as I was. In fact he even encouraged me to use explosives on his land. [Chuckling] That was a rare individual indeed.

Aaron: Yes. Definitely. In West Virginia, where I do most of my caving, a cave-protection and landowner-protection law, which says that even if a caver is given permission to go on the property, the landowner can not be held responsible because the feature [cave, sinkhole, etc.] was there prior to the landowner. Therefore the person who owns shouldn't be responsible for it if he or she didn't have control over it. That's probably due to the fact that there are so many naturally open cave entrances.

John: Yeah, I suspect that's true. There are a few cavers in Wisconsin trying to deal with that problem and trying to approach the Legislature to slowly get the wheels moving so we can change things. Since Wisconsin is our neighboring state, we have hope that if the situation works out over there, then we can pick up on it over here, and try and force the issues: [the first one being] cave vandalism laws, and second the liability issue.

Like you say, karst is not a hot topic up here. We have very little in karst features, and what we do have is located in the far south-eastern part of the state, and so if you would ask the typical person, "What do you think about caves?" they wouldn't have a clue what you're talking about. Furthermore they don't even know what a sinkhole is. When you get down into south-eastern Minnesota, you suddenly encounter thousands of sinkholes, but most of the farmers don't even have a clue of what's underneath them. They're just thankful they can dump their garbage and pesticides in the sinkholes.

Aaron: Are there springs?

John: Oh yes. In fact, I discovered a total water-filled cave in south-eastern Minnesota. There was a spring coming out of the side of a hill, and I was able to gain access to that, dove in, and found a spectacular cavern in there, but it didn't go as far as I had hoped.

Aaron: How about topography? Are there hills, ridges?

John: This state is incredibly varied. We have over 15,000 lakes, 6500 rivers and streams, which translates to 900,000 miles of shoreline. The largest Federal wilderness, east of the Rockies, which is called the Boundary Waters, lies in the extreme north-west part of the state. It's almost 1.1 million acres. When you travel to the northern part of the state, it's heavily forested. When you refer to Minneapolis-St. Paul, it's mostly flat terrain, though there are significant pockets of woods. When you travel to the western part of the state, it's mostly all-out flat cropland, but the south-eastern part of this state is very unique because it's unglaciated. The glaciers retreated well before they met the south-eastern corner of this state, and so we have fantastic limestone bluffs, rolling hills, meadows; it's extremely varied and picturesque.

Aaron: I was going to ask what effect the glaciation had on the caves, but it sounds to me that since there was no glaciation, you still can get access to them.

John: You sure can, and that's a good thing, but we are always reminded that the last glacial retreat brought with it copious amounts of water and mud. The caves were well formed before the last glacier and unfortunately the last glacier filled a lot of these caves up with sediment. It seems that the caves we're finding now were reopened by the water mass that flowed back through that area and reopened significant cave

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passages. You'll find significant caves, but you'll also find that many passages are almost filled with glacier till, some of which came from Canada, [i.e.] granite. It's a very beautiful part of the state.

Aaron: So because when you're in cave, and you're expecting sediment, then you can have an anticipation that the cave will continue if you can get through the sediment choke, right?

John: That's exactly right. We utilize cameras that we can probe ahead, but for the most part, if we get "cave signs" we'll go ahead excavate it the old-fashioned way, if we're in a cave, and go ahead and use our drag boxes and other digging paraphernalia.

Aaron: What are some of the biggest passages?

John: I would say 40-forty feet wide, by probably 20-feet tall. Those are some of the larger passages. Most of the passages are about, I would guess, 8-feet wide by 8-feet tall. That seems to be the norm, though we have significant amount of cave passage that is very, very tall. I was in one passage in my cave a few weeks ago, and we actually had a cave radio and measured it and it was about 140' tall.

Aaron: Wow, that's very big by any standards.

John: ... and of course we have the rivers and streams that run through the lower levels with aqua-blue green, crystal clear water just waiting to be dove. So there's a lot of varied feature in these caves: there's lots of horizontal walking, and also a good share of vertical climbing that one can do.

Aaron: The caves are certainly developed along the joints, but are they developed primarily along the dip or strike of the limestone in that area? Is there any dip or plunge to the bedrock there that controls cavern development?

John: We have anticlines and synclines, but we haven't really encountered those in a cave yet. It's fairly clear that you can be in one rock strata in a certain part of the county, and a mile away it will drop 40 or 50 feet.

Aaron: So there is some angle of the bedrock, but not that significant... pretty flat-lying limestone, then.

John: You're right about the caves being joint controlled, but when you get to the lower levels, if you do find a river or stream passage, it will meander with [apparently] no rhyme or no reason. So the maps look a little strange.

Aaron: That's interesting.

John: We can predict where we're going to find new passages based on the joint-control history. We can predict that every 50 to 75 feet, for instance, we're going to hit a north-south passage, so if we're digging in an east-west passage, we know that we've got a certain number of feet to go before we'll probably get a cross joint.

Aaron: Do some of the caves have maze passages?

John: Only in the lower levels where the water meanders... at least in this part of the state. There are maze caves further to the east in the south-eastern corner. For the most part, where we're caving actively, there are no real maze caves.

Aaron: So, let's see... we've hit on a lot of topics, and we've been talking for about an hour. That's usually what we do. Is there anything that we've missed that you want to talk about?

John: We should touch a little bit on the Department of Geology and Geophysics at the University of Minnesota. They're really considered to be the most leading authority around the world regarding speleothem analysis. Dr. Calvin Alexander is heavily involved in this. They're attempting to understand the

causes behind the formation of the speleothem bands and the factors that control the thickness of these bands, whether these bands are annual, whether these bands can be used for dating speleothems, then finally to construct climate and vegetative history.

Aaron: So is this research ongoing on the Cave Farm?

John: Yes, it is.

Aaron: Ahh, good.

John: In fact, the University is sampling or testing speleothems from around the world. It's very exciting.

Aaron: Is there any other research ongoing?

John: Well, yes, there are dye traces that are going on all the time, and there are many factions of studies that are going on by different groups including folks from the DNR. It's very exciting to see that happening.

Aaron: Well, you have a perfect place for it to happen, certainly. I think without the involvement that you've had in there, it wouldn't be possible for people to be doing that kind of research.

John: I consider myself the temporary steward of these caves, and after I'm either killed in one of them or after I'm retired, the caves will continue to be there for the researchers and cavers, alike.

Aaron: That's good. That's great. Well, John, it's been nice talking with you.

John: Yeah, I appreciate it. I enjoy the magazine.

## Manifold.....Photoshop... Picture Window.....DJVU and the Digital Survey by Mark Passerby

The following article is an abbreviated attempt to convey the methods and processes involved in using software tools to converge rough survey data and sketches into useful digital maps. The software tools used include Picture Window, DJVU, Manifold, Compass, Photoshop, and vector graphics drawing software. I hope this can be of some using in moving the survey from the file cabinet to the digital landscape.

### Beginning the Process:

In the Raders Valley Project we have organized a workflow that has proved efficient and effective for rapid display of relevant working maps of ongoing cave survey projects. The process begins in the cave with data being collected and a sketch being drawn. While some of the data collection tools are beginning to evolve the process remains largely the same. What has changed drastically are the map-making processes applied after the data and sketches leave the cave and are brought back home.

In our case, Bob Kirk is the Raders Valley Project's keeper of the raw "paper" data and thus is charged with typing the survey data into Compass. He then scans the notes at 180 dpi and uploads the Compass .dat files and scanned notes to a dated survey folder on the Projects internet server. From here all project members will have access to the critical data via the internet.

### The Working Map:

After the survey trip, everyone in the group will be expecting the updated working map soon. In our case, I use FTP to transfer the scanned notes from the server to my laptop for use in assembling

the working map. Once the updated working map is complete, the entire high-resolution image is encoded to DJVU format for display on the web for project participants to view.

### What to Morph??

In my example I will present only one workflow model for the morphing process, but bear in mind that other models I have seen in use follow a much different flow and opt to only morph the line plots survey stations with relevant points on the working sketches. In my opinion this represents a somewhat flawed approach in that relevant wall points at each station are not accurately reflected. Further I would argue that even the examples here while representing a higher # of control points and accuracy still contain flaws that with minor changes in cave can be eradicated as well. All of these what I call "step ups" can be done with little or no time added to

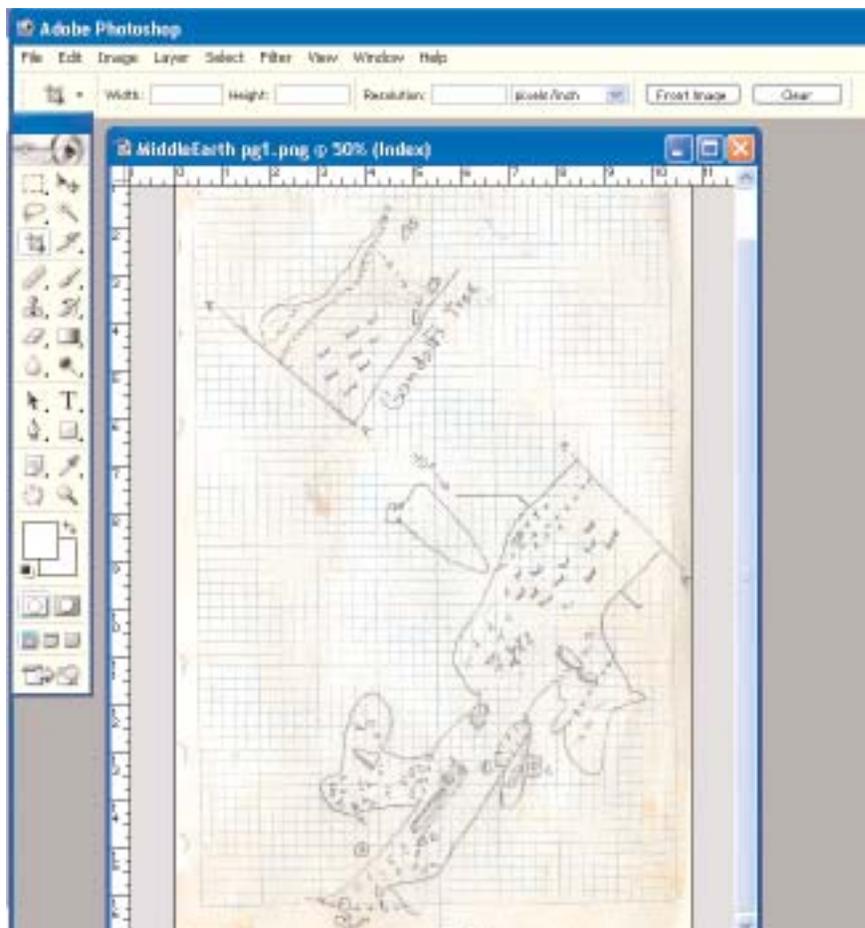
the entire process.

### Adobe Photoshop 7:

With the scanned working sketches now in hand I begin assembly of the working map. In my flow no morphing is done until a large part of the survey is complete. Then using Picture Window 3.1 large chunks can quickly be morphed and then registered in Manifold. My example uses Adobe Photoshop 7, but earlier versions and even other photo editing software I am sure have similar processes.

The process is designed to take a scanned sketch with all of its imperfections i.e. mud, graph lines etc. and separate out only the relevant penciled lines for use in assembling the working map. Once learned it is a very quick and an efficient process.

Open the first scan.....



Continued on Page 12

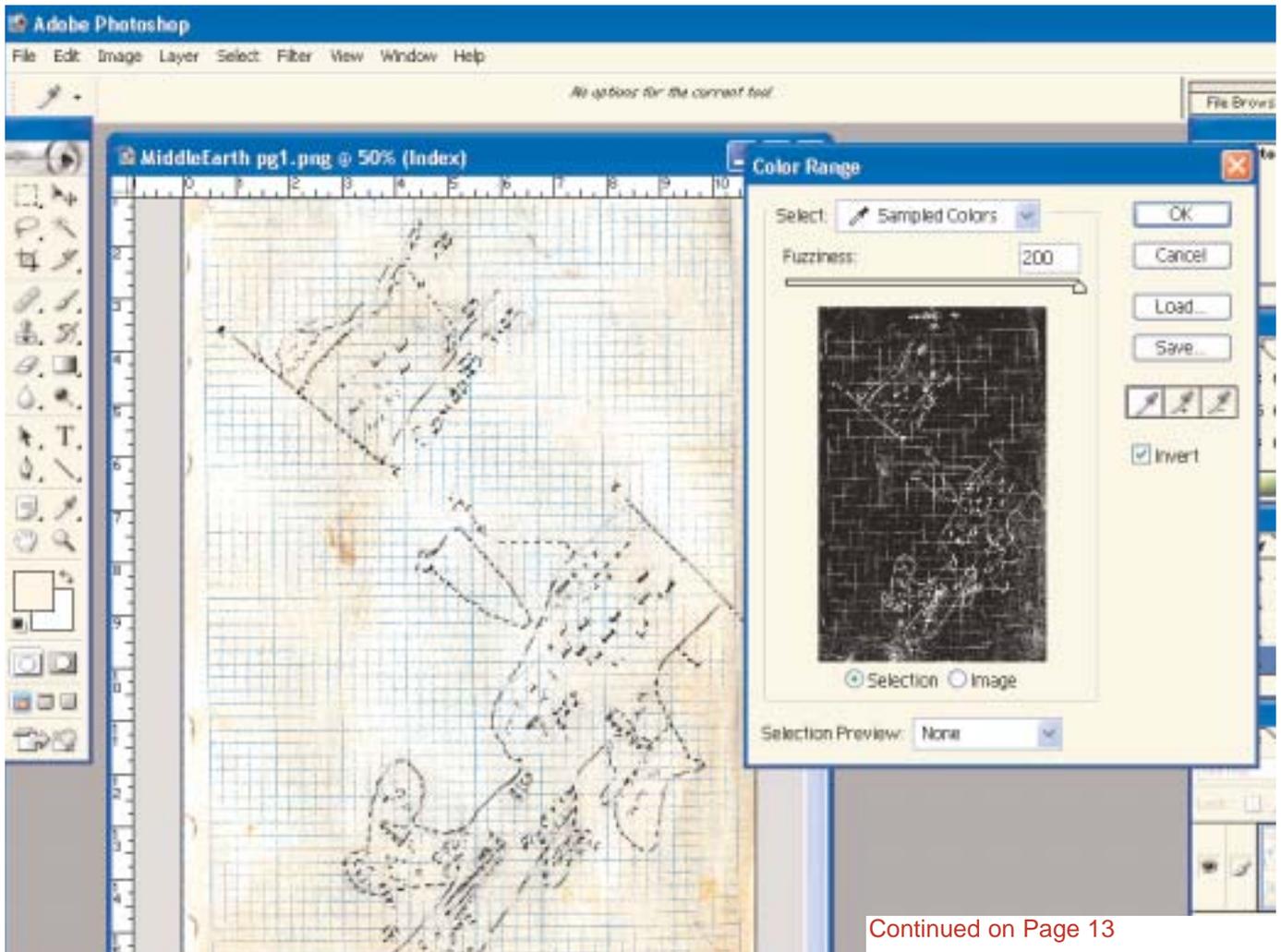
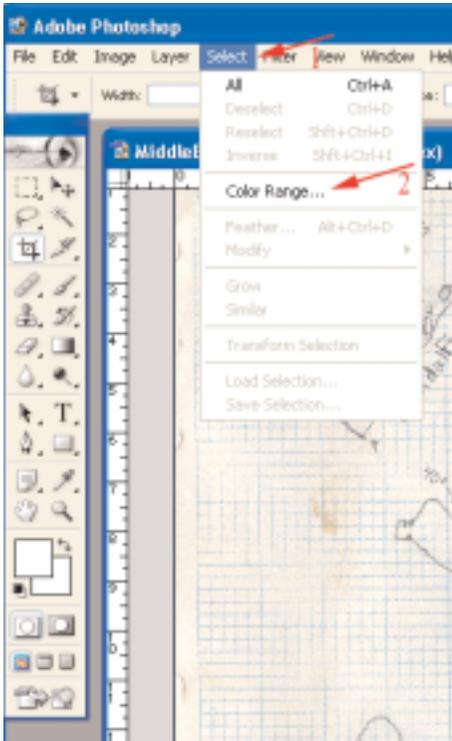
On the toolbar.....go to "Select" then choose "Color Range"

Then.....

Make sure your working map image is already opened in Photoshop or that you have a new blank image/canvas ready to begin the process of building your working map.

Now in your color range tool make sure that the "Invert" option is checked and the fuzziness slider is adjusted to the far right. The fuzziness slider can be adjusted to different levels as you become experienced with the tool. I also select the middle "eyedropper" position located just above and to the right of the Invert check. This will allow you to select multiple spots on the working sketch that will help to quickly isolate only the penciled in portions. Begin now to use your mouse to click on the scanned working sketch on points other than the penciled in drawing portions.

You will begin to notice in the Color Range box that the penciled-in portions are staying white whereas the unwanted parts are now illustrated as solid black. What you should see are that the penciled-in portions are highlighted on the image of the scanned sketch. Once this is successful, and while the penciled-in portions are still highlighted, use the keyboard combination of "ctrl" + "c" to copy. Now highlight your working map image and use "ctrl" + "v" to paste the penciled-in lines of the sketch into a new layer of the working map. You now have only the penciled in lines of your sketch in a new layer in your working map and can quickly move it into place using the move tool in Photoshop. Once this is complete with all the scans from the recent survey trip I save the entire working map layers as an Adobe .PSD file then additionally "flatten" the image and save it as a .tif at 180 dpi which can then be named for



Continued on Page 13

example 712003WorkingMap.tif. The .PSD file named WorkingMap.PSD will be used after the next survey trip to add additional survey onto the working map and the 7122003WorkingMap.tif is used in DJVU to generate a DJVU encoded working map for display on the web immediately. Each time the PSD is

updated, a new .tif file is generated that is used to encode a new DJVU for the web, and this will keep the project participants happy to see the fruits of their labor.

sharpness and result in far more "loss" in quality.

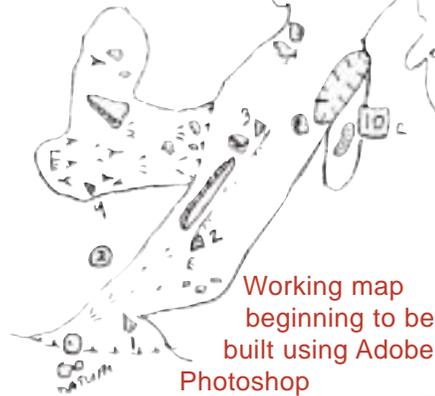
In my opinion DJVU encoding and Lizardtech's DJVU editor

represent the ideal solution for display on the web of high resolution working and finished cave maps.

### The DJVU Editor:

Below is a screenshot from the DJVU Editor 4.0. Once the .tif image has been converted into a .djvu image the .djvu image can then be further edited with drawing tools and hyperlink boxes etc. In the example below I have added a book and a camera to the working map in Photoshop. Then once converted to .djvu I can use the Editor to add for example a hyperlink to the book so that when a project member clicked on the hotspot they would open a new

window with a relevant trip report from that particular survey trip. The camera as well would be used to provide a hyperlink to a relevant photo of that area of the cave and so on. The possibilities are endless, but remember to read the "help" sections as there are many functions that can be used to tweak the djvu-file even further. One important thing to learn is the process of embedding the .djvu image into an .html page which enables you to add some text and a "regular" link for users to download the browser plugin that is needed to view the image online. This is important to remember because if the .djvu is left as a standalone image the user without the DJVU Browser Plugin would be left with a blank window. Embedding the .djvu in the .html of the page is recommended to insure that they can be given the option to download the browser plugin. The process of embedding is fully explained in the Help Menu. Also included in the Full Version is a somewhat watered down version of Macromedia Freehand which can be used to add drawing functions to the editing process on a

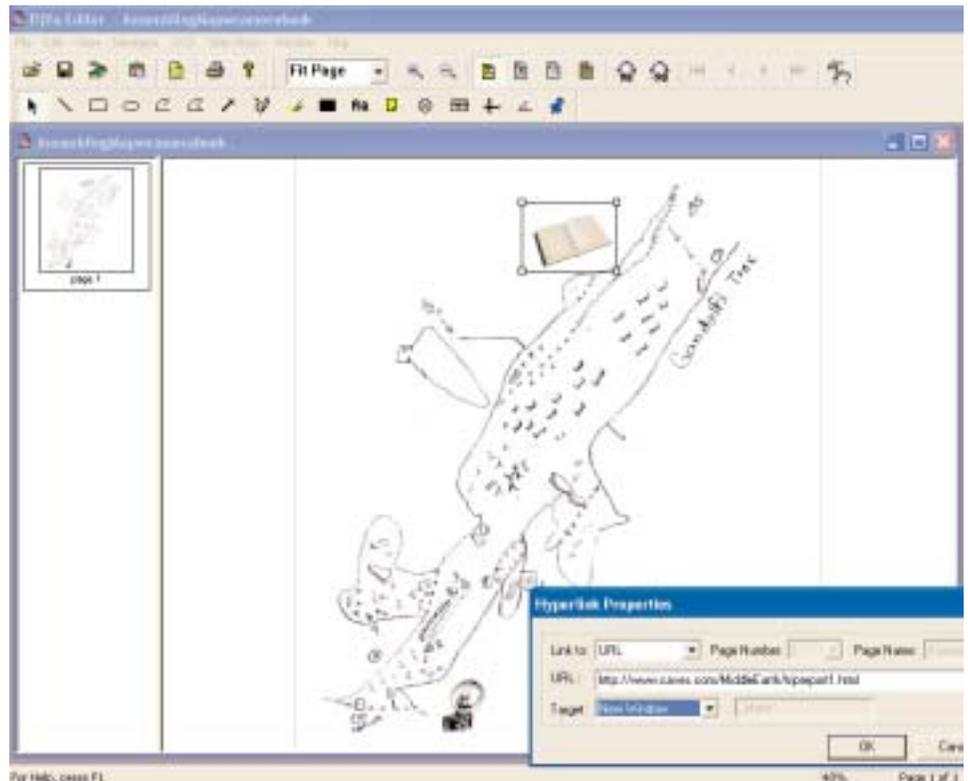


### DJVU Encoding:

Many years ago Lizardtech <http://www.lizardtech.com> developed a tool for compressing very large document scans and photos to a format they termed DJVU. They introduced it largely through the use of a "free" non-commercial version of their converter and DJVU editor. While the free version is no longer available the regular version is for larger projects a worthwhile investment.(approx. \$250) A 250 image trial can be downloaded at:

<http://www.lizardtech.com/solutions/document/trial/>

Another option is to convert to a compressed .pdf file, but comparisons by me of the two show that not only are .pdf's far bigger in file size they also lack the



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.djuv image.

## Morphing:

In my opinion, morphing represents the critical step in the process from working map to final digital map. In days past a final map would be hand drawn or traced using the working sketch and a line/wall plot as reference points. The relevance of the wall points is something I will discuss later in this article but suffice it to say these points have and will continue to be critical control points in the drafting of a final map. Software in use currently, such as Winkarst and Cartos, morph the line plot by using survey stations as control points; however, they leave out the left and right points at each station. In small passages without high angles, this process will suffice. However, where it begins to break down is in high-angle, wide, or improperly sketched passages. Acknowledging this then requires that the data collection process be changed a bit to insure that the data later can be used to generate relevant control points for the final morphing sequence.

Conversations with Miles Drake, Aaron Bird, and Bob Kirk have solidified my opinion that such data collection can be done on every survey without slowing down the process and ultimately achieving a far more definitively accurate representation of the cave.

The image to the right is a section of Middle Earth that has

and the relevant left/right at each station. It looks to be a perfect image and a great background layer to begin the final map trace in your favorite drawing program, but actually it has flaws.

The cause of these flaws is in the standards most of us now use for data collection. This can and should be changed.....

For this I initially used Manifold but opted to later use Picture Window 3.1. For those choosing to only morph the survey stations of the line plot, any of the existing programs, i.e. Manifold, Cartos, or Winkarst 10 will suffice. For my example, however, Picture Window 3.1 seems to be the only program capable of the high-speed morphing required for inclusion of a large number of control points along the main survey and at the walls.

Morphed Section of Middle Earth

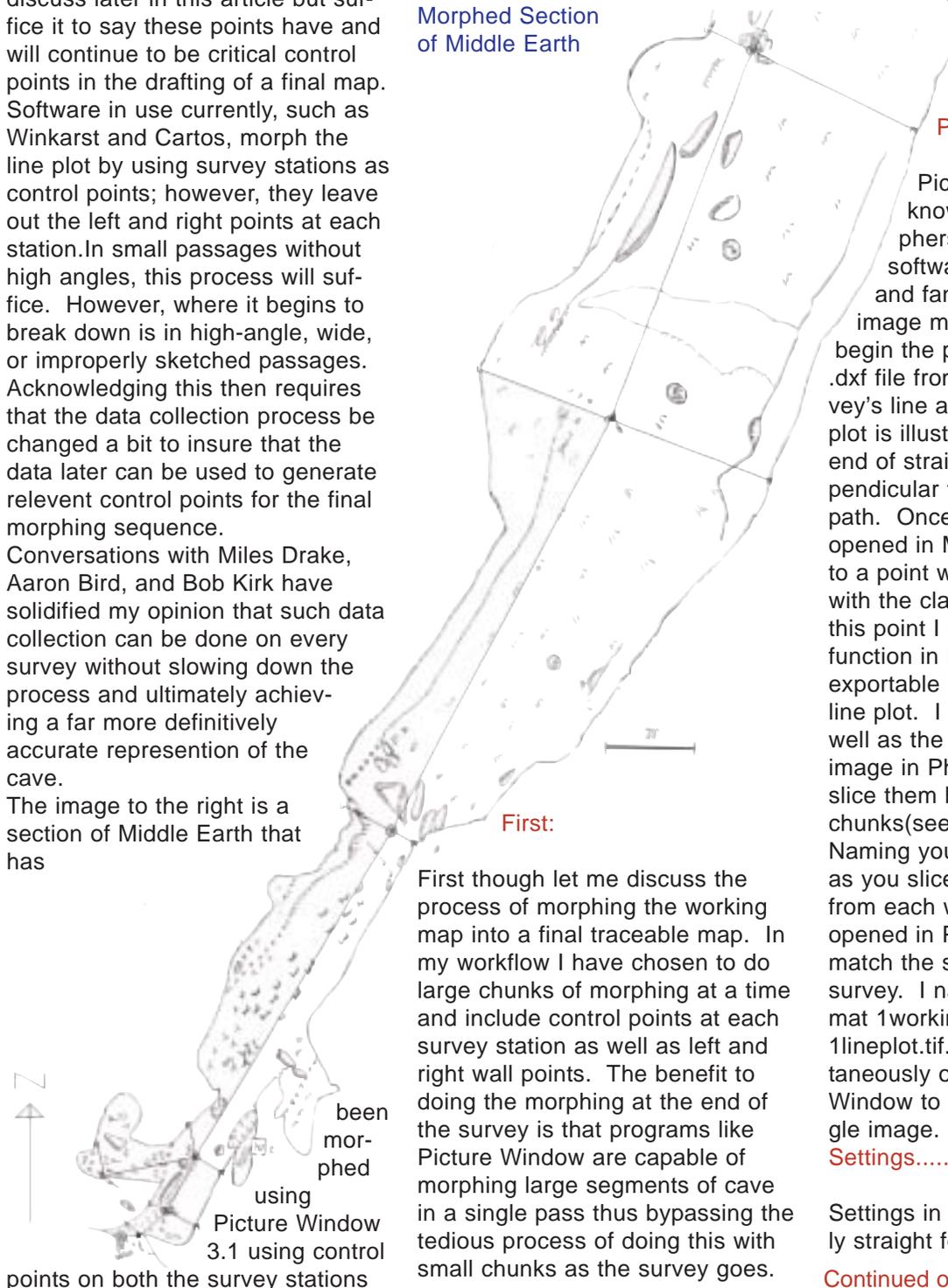
Picture Window 3.1

Picture Window 3.1 is known mainly by photographers as a photo editing software but its lesser known and fantastic feature is its image morphing abilities. I begin the process by exporting a .dxf file from Compass with the survey's line and wall plots. The wall plot is illustrated as L and R at the end of straight lines that are perpendicular to the relevant survey path. Once exported the .dxf file is opened in Manifold and zoomed in to a point where I feel comfortable with the clarity of the image. At this point I use the "make image" function in Manifold to create an exportable image of the entire .dxf line plot. I then open this image as well as the now large working map image in Photoshop and cut or slice them both into corresponding chunks (see image on next page). Naming your slices systematically as you slice corresponding chunks from each will insure that when opened in Picture Window they match the same locations of the survey. I name each set in the format 1workingmap.tif and 1lineplot.tif. These are then simultaneously opened in Picture Window to be morphed into a single image.

### Settings.....

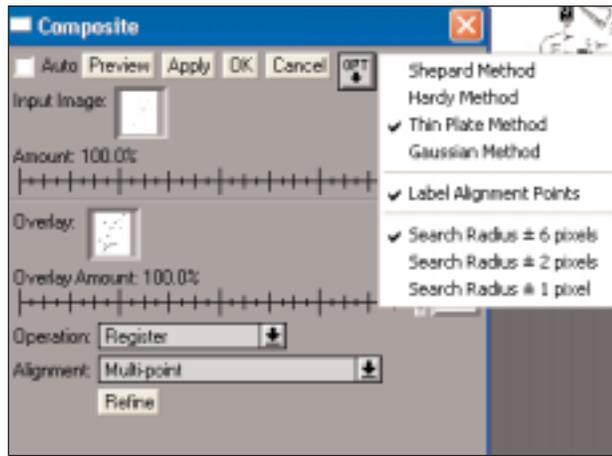
Settings in Picture Window are fairly straight forward. Once corre-

Continued on Page 15



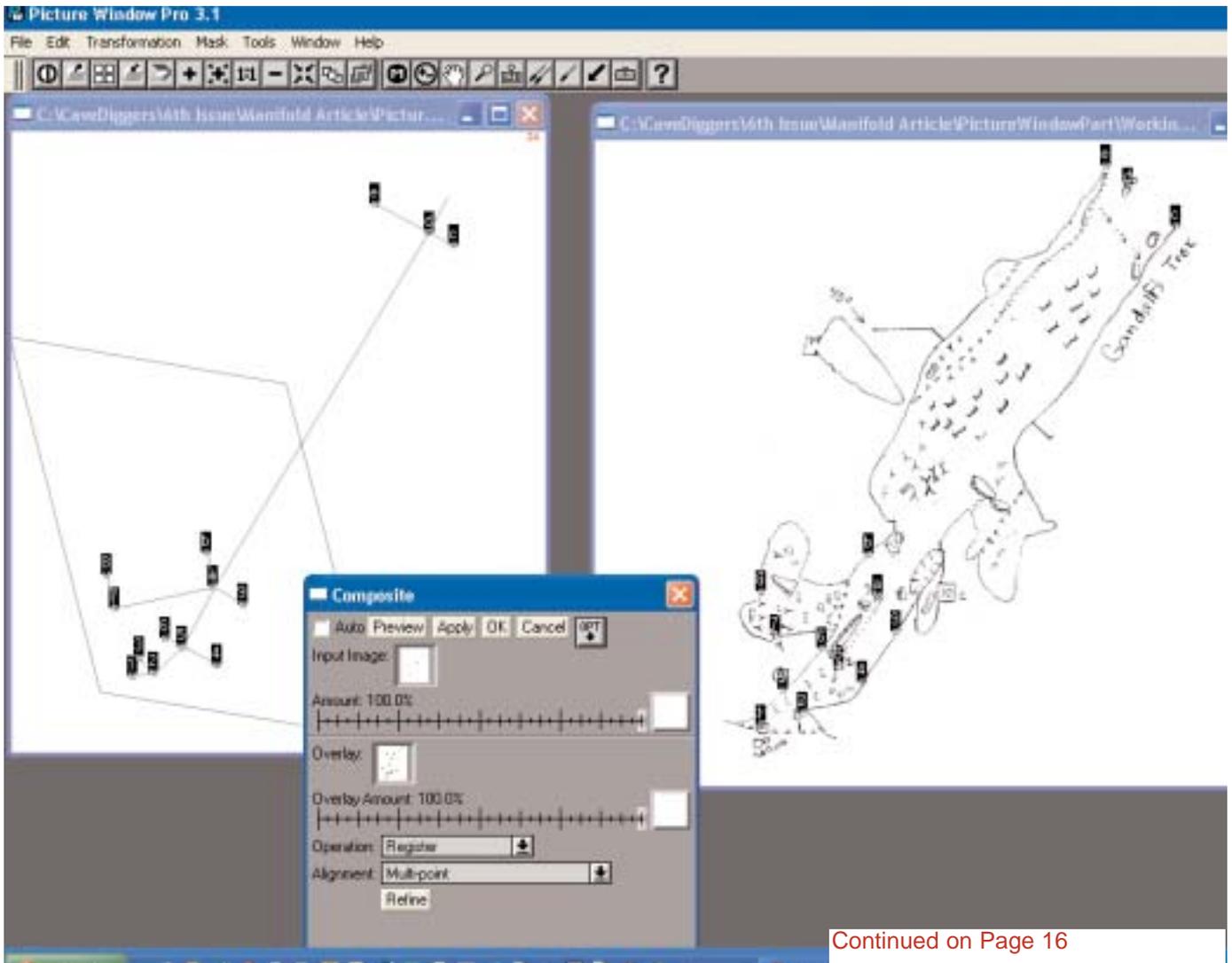
First though let me discuss the process of morphing the working map into a final traceable map. In my workflow I have chosen to do large chunks of morphing at a time and include control points at each survey station as well as left and right wall points. The benefit to doing the morphing at the end of the survey is that programs like Picture Window are capable of morphing large segments of cave in a single pass thus bypassing the tedious process of doing this with small chunks as the survey goes.

spending images are opened go to the “transformation” option on the toolbar and choose “Composite”. This will bring up the composite toolbar(see image to right) at which point you choose the “thin plate method”. For the “Input Image” choose the lineplot image and for the “Overlay” choose the working map image. Then for “Operation” choose “Register” and for “Alignment” choose “Multi-Point”. This final step will lay down three control points in each image which should be positioned at the first station and then at corresponding control points on each image starting from bottom to top. To add more points simply hold the “Shift” and left click your mouse nearby on your “Input Image” or in this case the lineplot image. Because you are zoomed out so far you will only be able to approximately position the points



on each image but this can be taken care of quickly later. Up to 60 control points can be placed prior to registering. Once all points are closely positioned simply zoom way in on the images and use the keyboard to type for example “1” which will bring you instantly to control point #1 in the image at which point you can precisely position the point...then 2, 3, 4, etc. in

both images. Once this has been done satisfactorily, click the “Preview” button to view what will be the results of the final morph. If satisfied click “OK” to morph. You will now have a single image of the working map section fully morphed to the control points you placed on the relevant sections of the line/wall plot. How many accurate control points you ultimately have depends on your methods of data collection. Save this image for example as FinalSection1.tif. This image can then be registered in seconds in Manifold where the final map pieces will be assembled over the lineplot. Once in manifold it can be zoomed in and out with images produced for use in a drawing program as a back “tracing” layer.



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## Data Collection:

On page 14 the illustration of a final morphed image looked perfectly adjusted and matched to both the survey line and the wall plot. The flaw of course as mentioned is in the data collection method of estimating left/right points at each station. Whereas this process may be "accurate enough" in narrower level passages it is inaccurate in its final representation in this example. In my example the passage actually slopes at about 40 degrees therefore an estimation of a right wall of say 30' without taking into account the declination results in not only an inaccurate penciled sketch but also inaccurate sets of control points generated for the walls in the .dxf export from Compass. How this can be simply corrected was the topic of a discussion between Bob K, Aaron B, Miles D, and myself at Digcon03 this year. As a result of those conversations our next survey trip into Middle Earth will be the first adjustment of our data collection methods.

## New Collection Process:

At the entrance of each new cave survey actual splay shots will be taken from the first station to the left and right sides of the opening to the outside. This will establish relevant control points to be used in the morphing process to accurately and digitally redraw the penciled in-cave sketch to actual data collected. Subsequent stations will no longer have left/right estimates recorded, but instead will be Disto'd as splay shots on a 90 from the survey path. Only when passage dimensions are narrow enough will it be estimated. On a high angle an inclinometer will be used to measure the angle to the furthest point left and right. In some cases a wall ceiling projection may block the view or other obstacle cause a problem. In these cases a "rough" reading will be used for the inclinometer reading and either a Disto or estimate

used for the distance. The azimuth would be a 90 to the survey path.

**Example:** Starting at a caves entrance shot....Station 0 to Station 1 has an azimuth of lets say 90 degrees or due East. Station 0 would also have actual splay shots measured and completely shot to the left and right points of the entrance opening thus creating highly relevant control points for morphing later. At Station 1 a splay in this case named Station 1WS(#1 West Splay) and Station 1ES(#1 East Splay) would be either estimated or in cases of wide or high angled passages measured using a Disto and or an inclinometer. What methods are used at each survey station and/or frequency will solely depend on the # of accurate control points that are desired in any given area. In wide or high angle areas our method will be at every station but in narrow and level passages perhaps this will be done only every 3rd station or so. What is important is that everyone in our survey team understand the nature of control points and where their accurate measurement is deemed more desirable for the final morphing processes. Splays will be appropriately named so that they can later be deducted from the survey total will however replace the estimated left/right measurements we now use. The entire focus will be directed to attempting to collect more relevant control points for use in the .dxf export and eventual morphing in Picture Window.

Picture Window Pro 3.1 **Free** 30 Day Trial Version can be downloaded at:

<http://www.dl-c.com/>

**Because of its precise registration capabilities Picture Window has become a favorite amongst astrophotographers for combining multiple images.**

Manifold GIS is a great and relatively inexpensive product for projects and long cave systems where a lot of data is being collected in regard to the geology, biology, and hydrology. Using Manifold this data can be related visually back to the cave survey and stored, shared, and displayed either as a Manifold .map file or published on the web.

I will go over a few highlights of the program as it relates to the cave survey, working map and final map. More can be learned by visiting the Manifold site at

<http://www.manifold.net>

## Morphing:

My first reason for beginning to use Manifold was an interest in its morphing capabilities. For morphing **only** the line plots survey points to relevant points on the working sketches the program works fantastic. For many this type of morph will be sufficient but in our case I decided to bring in the much larger # of relevant wall points at each station which proved to be at times a bit frustrating using Manifold. I opted to use Picture Window instead which seemed more optimized to perform this very specific more demanding type of redraw. For those choosing to only morph the line plot I will briefly go over the steps using Manifold to correctly register/morph the working sketches to the .dxf line drawing.

## Manifold GIS:

Open the .dxf in Manifold which actually gets imported as a drawing initially and displayed in the project window as a MAP. So open the map of the .dxf and the first sketch section you want to morph. Then go to "view" "panes" and choose "control points". This will make available the control points tool which will allow you to begin to drop control points onto each piece. I start from the bottom and work my way to the top only putting control points on the actual survey sta-

**Continued on Page 17**

tions on each object. NOTE: because the MAP(.dxf) is a drawing you can use the snap to line function on the top toolbar to quickly put exact control points down on the .dxf part of the control point position. Once you have satisfactorily placed matching points on each object click on or make active the working sketch image and in the control points tool select to register to the map(.dxf) file then choose the affine method and click OK. The morph will take place and then you can go to your map(.dxf) window and right click to quickly add the working sketch layer to the line plot. You can then move layers around to put the line plot on top or turn off the line plot, change opacities, register other relevant geology layers and so on.

oped by David Brubacher in Canada and will allow for the raw data to be input directly into Manifold which will then process and display the line plot drawing. As the script becomes more and more robust the tight integration will allow for easier executions involving morphing, painting surveys on to terrain views, and display on the internet. When properly done a project member will be able to not only view different aspects of the survey project online but also see live UTM coordinates by simply dragging the mouse over any part of the cave, turn off and on various layers built into the project as well as view and manipulate other relevant GIS data from the project.....all online.

my final choice for use in our projects. It's tight integration with Flash MX makes it ideal for developing cool flash movies using the drawings created in Freehand. Other tools such as Xara X have the ability to export to Flash(.swf) but lack the tight integration that is possible between Freehand MX and Flash MX. Below are some of the most used options and their pricing.

Xara X-- [www.xarax/products/xarax](http://www.xarax/products/xarax)  
Free 30 day trial.....\$149 U.S.

Adobe Illustrator 10--[www.adobe.com](http://www.adobe.com)  
Free Trial.....\$399 U.S.

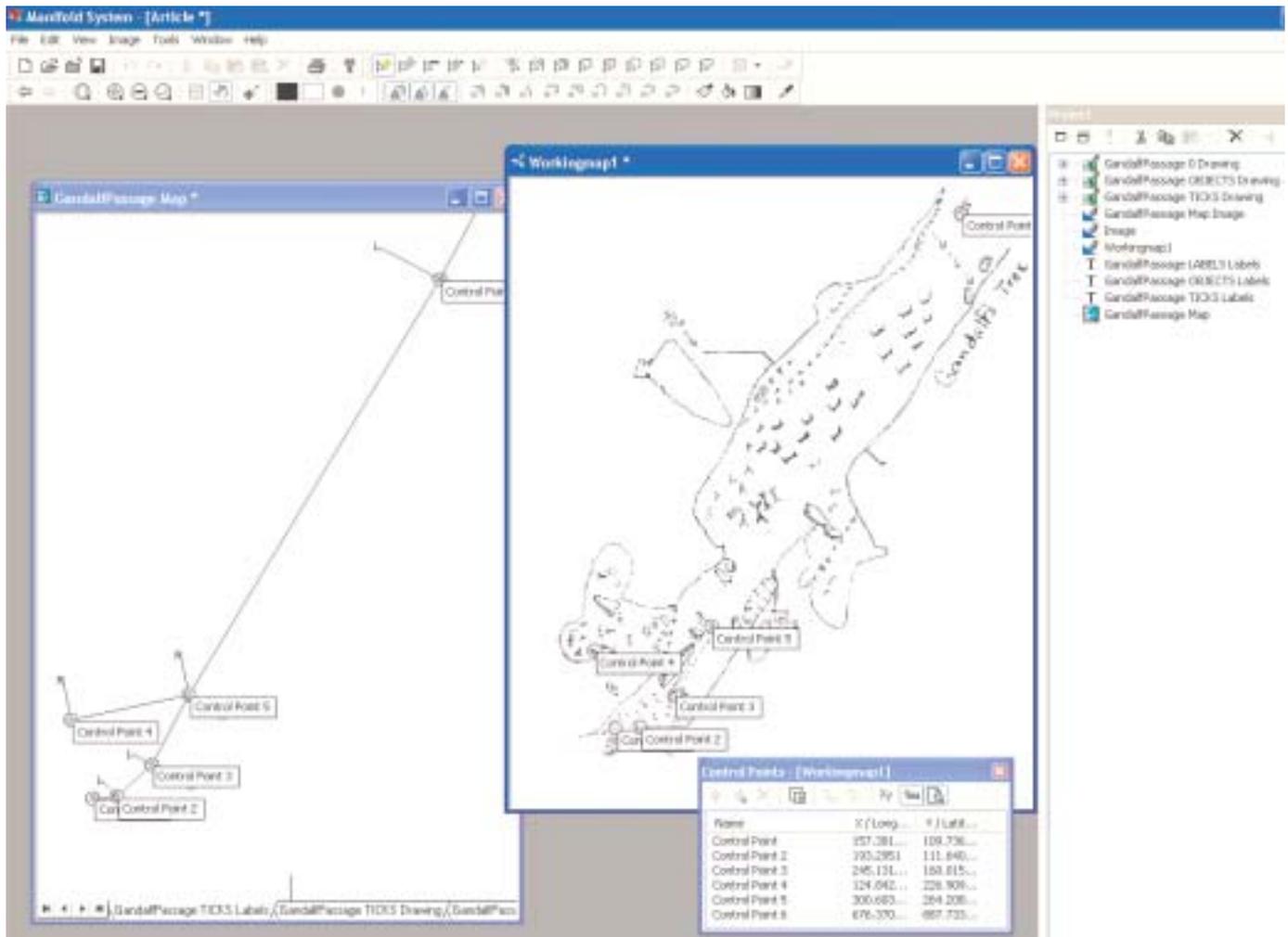
Macromedia Freehand MX----  
[www.macromedia.com](http://www.macromedia.com)  
Free 30 day trial.....\$399 U.S.

**Cave Script for Manifold:**

Perhaps most exciting about Manifold is the development of a cave survey script that will work within the Manifold project environment. It is being devel-

**Drawing Programs:**

I have over the past several months played with a few of the drawing programs. I am particularly impressed with the newest version of Freehand i.e. Freehand MX and have made it



## A DIGGER'S DAY

By Glenn Ledbetter NSS 32198  
(reprinted with permission from Cullman  
Grottos "The Flowstone" May 2002)

Back in late march I went on a solo ridge walk. I located a known cave, Erwin pit, ACS #2559. It's a fifty footer I had wanted to do for some time now. While looking for it I found a small hole that sounded to be in the 30' range. Then I found another dig, I guess you could call it a mining project, but it sounded pretty deep. Later on April 5, I put together a small crew for a digging trip. Jeff Lynn, Terry Ragon, Chrissy Frotten and I made our way up to the first small hole. After about 10 min. it was open enough for Chrissy. She slid in and dropped a 20' pit only to find no way on. Oh well, another karst feature checked. Time to walk farther. We made our way to the next dig site to look at the lead beyond. The lead to be was a small hole under a rock that you had to lay down on your side to toss a rock into. We dug out quite a bit of dirt and mud then broke out the shaving kit. We made two micro blasts that moved lots of rock; enough to get a slight look at the hole but that was all. That's enough for the first day but we will return a few more times for mining in the near future.



**Jeff Lynn & Glenn beginning the dig** Photo by Terry Ragon

Later on April 10 Jeff, Terry and I planned to return and dig more on the hole. Jeff was unable to make it but Terry and I made our way up the mountain on my ATV. The ATV makes short work of the hike especially with digging gear. We began digging out dirt then set one micro blast and removed the shattered rock. Then we took a piece of webbing, tied it around a large rock and pulled it out of the way with the ATV. Then we dug again to a rock shelf, this is where our luck went sour. We drilled a hole pretty quick but the

firing pin in the rod drove up into the rod not setting off the shot. Then we tried other ways of detonating but nothing worked. All this happened as the rain started falling. We decided enough for now loaded up and headed for the trucks getting thoroughly soaked along the way. We were able to get a better look at the hole and drop more rocks, it still sounded deep! A few more trips will tell.



**Diggers R Us Timed release**  
photo by Terry Ragon

Ahh, trip 3, virgin cave by the inches. April 18. Terry, Glen R., Jeff, Evon and I made our way back to the dig site. We were able to set off a few micro blasts and enlarge the crack. I tried to squeeze through but was unable to with vertical gear. Terry gave it a shot and was able to get in but was concerned about dirt and loose rocks. He dug a lot off the ledge but decided not to go any further. Finally, out of bang and drill battery. At this point we have dug approximately 4-5 feet deep using techniques from micro blasting, hammering and an ATV to pull out rocks. More trips will tell and it still sounds deep!

Oh yea, fourth trip. On Friday, April 25th another digging, "mining", trip was planned. The crew for the day started off with Terry, Chrissy, Evon, Corona Greg, Harold and Myself followed later by Jeff. We arrived at the parking spot unloaded the ATV's again.



**Caving is much easier these days**  
Photo by Evon Thompson

[Caves.com](http://Caves.com)

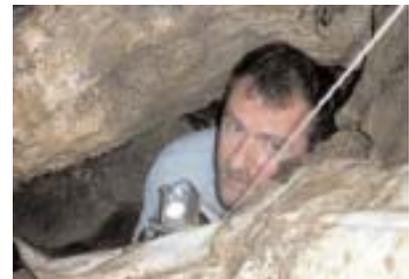
We made our way to the dig site and set up an array of tarps for the rain in the forecast.



**Gimme Shelter**

Photo by Evon Thompson

That done Terry broke out the new hammer drill. What a great present Chrissy, I'm sure we will all have a lot of fun with it. The drill made short work of 3 more micro blasts and opened the crack enough for Terry to ease into. He spent about 15 minutes clearing debris from the ledge below. After he got tired I slid in to finish the work. That's when we rigged a rope and I was able to drop the new pit.



**Glenn makes the first ascent**  
Photo by Evon Thompson

After untangling the rope on the next ledge and peering down the shaft, I could not see anything below but the rope dangling in darkness. Excitedly I dropped to the next ledge only to see the rope barley touching. Once on bottom I started the climb back up admiring all the great flowstone formations all around the pit. Once up Terry made the drop and taped the pit to the magical 100 feet! Every one on the trip bounced the new find. Part of the most fun of the day was watching people come back through the tight spot. Terry sketched out a map. We are calling the new pit "Shot in the Wall" for reasons you will have to see for yourself. The pit is absolutely beautiful. Finds like this one are still out there. TAG is a long way from being pushed to the bitter end, it just takes a lot of hard work and plenty more walking looking for just the slightest hint of a cave below. Thanks

Continued on Page 22

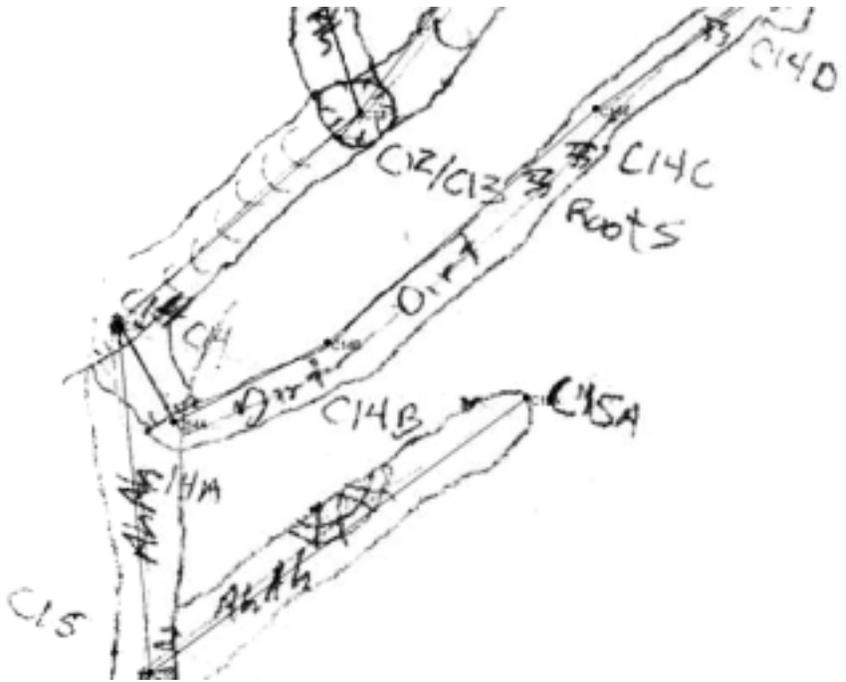
# WinKarst v10.0

Garry Petrie

The latest version of WinKarst, v10.0, continues to expand on features introduced in version 9.0 and gives it a unique position in the domain of cave surveying software. The two most important improvements are sketch morphing to the lineplot and geo-referenced color background images. WinKarst is the only program to allow the user to dynamically edit the underlying survey and morph the associated sketches to the new lineplot. While other programs can display bitmaps, only WinKarst can associate points in the bitmaps to surface coordinates and display the image scaled cave survey.

The following sketch of a junction area in a cave shows the typical problem encountered in stitching together several sketches in a survey.

The lineplot for the middle dirt lined passage is off with respect to the calculated lineplot. The junction at station C14 does not match with the main line of the cave. After morphing the sketches, WinKarst



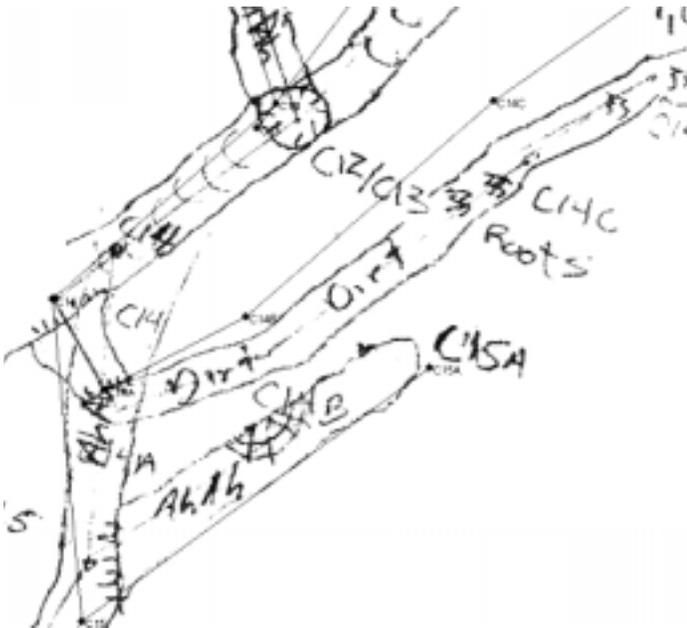
capture below shows the map page from the editor.

In this case, the control point UL is located at UTM coordinates 559000 and 5107000, zone 10. For topographical maps with UTM grids, registration is an

easy task. The user must extract either road or stream junctions from the field or topo maps for aerial photographs. Once the user registers at least two points, then the software draws the cave lineplot on top of the image of the map, scaled and rotated. WinKarst will not morph bitmaps used as backgrounds.

an individual set. When SDTS/DEM data is available, WinKarst can calculate the over-burden at a station and color the thickness in proportion to the color scheme. The over-burden drawing can suggest locations to look or dig for new entrances. The backsight recognition applies to surveys with fore and backsights and in which the surveyor corrected the backsight. The software automatically recognizes the variation in technique and marks the shot as a corrected backsight.

WinKarst is \$25 shareware and has a 30-day trial period. It runs on all Windows based machines. The self-extracting installation includes help and example files. Owners of previous registration numbers can upgrade free of charge. For more information, see <http://www.resurgentsoftware.com/winkarst.html>

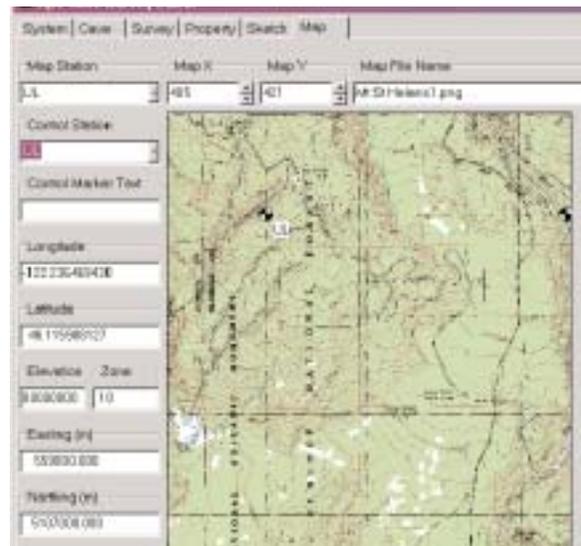


produced the following image.

WinKarst pulls the passage on to the lineplot after morphing. The correct relative placement of the three branches is now apparent and drafting the cave map can proceed immediately.

WinKarst can register bitmaps to either latitude/longitude or UTM coordinates. The images, in PNG format, can be topographical maps, aerial photographs, property plots, etc. The map page of the editor allows for the creation and placement of control points on the image. The screen

Version 10 has other enhancements and includes survey grouping, coloring by over-burden thickness, more information on station labels and automatic corrected backsight recognition. For caves with a very large number of surveys, WinKarst can group surveys into sets and then display





**True North Technologies**  
**2 Clock Tower Place, # 335**  
**Maynard, MA 01754 USA**  
 Ph: 978-897-5400 • Fax: 978-897-1144  
 Website: [www.tntc.com](http://www.tntc.com)

## *Revolution™*

### **Strapdown Electronic Compass**

#### **General Description**

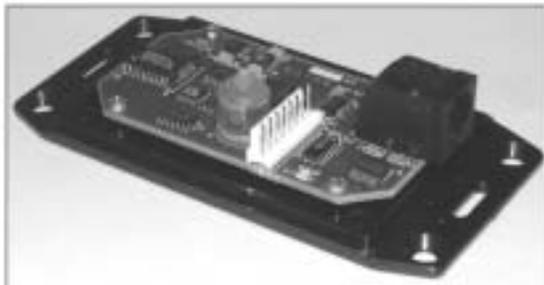
Based on True North's field-proven technology, this evolutionary device represents the state-of-the-art in magnetic compassing. It combines a precision 3-axis solid-state magnetometer and a rugged 2-axis electrolytic tilt sensor to provide accurate heading and tilt measurements over a wide range of environmental conditions. The firmware and signal processing algorithms have been refined and improved over three prior generations of compasses to deliver the ultimate in performance from the available sensor data.

A key advantage of the Revolution is its quick-connect, external serial interface. While the compass is in-place, and without disconnecting system wiring, a companion PDA can be temporarily connected via the RJ12-style modular jack. This allows easy access during installation for calibration and tuning. It also provides a valuable diagnostic port and can be used for an auxiliary read-out when needed. In situations where a fixed installation is not desirable, the RJ12 connection can be used exclusively.



Among the host of user definable operating parameters is the selection of NMEA output data and update rate; operating mode as continuous or query-only; and angle data in degrees, mils, radians, or 16-bit integer (65536 counts per revolution). Compensation for both hard and soft iron influences is built-in, and the companion PDA can be used to perform specific calibration procedures.

True North offers a development kit that includes the compass and companion PDA. Both devices are covered by a full one-year replacement warranty.



#### **Features**

- **High Accuracy**
  - ⇒ Heading within 0.5° or better
  - ⇒ Tilt within 0.2° or better
- **Wide Operating Range**
  - ⇒ ±40° Pitch and Roll
  - ⇒ ±80° Dip angle range
  - ⇒ Temperature 0° to 150°F
  - ⇒ Local Hard Iron to ±1 Gauss
- **Fast Response**
  - ⇒ Up to 20 readings per second
  - ⇒ Wake from standby in 75 msec
- **Single Supply Operation**
  - ⇒ 5 to 25V unregulated DC or
  - ⇒ 5 V regulated DC
- **Low Power**
  - ⇒ 15 mA operating
  - ⇒ 5 mA sample, 1 mA standby
- **Wide Selection of Output data**
  - ⇒ Heading, pitch, and roll
  - ⇒ Magnetometer X, Y, and Z
  - ⇒ Dip angle
  - ⇒ Total, horizontal, and vertical magnetic field strength
  - ⇒ Horizontal X and Y magnetic field strength
- **Choice of Interface**
  - ⇒ Full-duplex RS-232
  - ⇒ Full-duplex RS-485
- **In-System Configuration and Test**
  - ⇒ Palm PDA can be connected while unit operates in situ
  - ⇒ Perform hard and soft iron calibration
  - ⇒ Monitor outputs and change user-definable settings

Memorial Day Cave - May 2003  
Update – Surveys, Columbia, and  
Flooding.

by Devin Kouts

Beginning as a tight dig in hard Germany Valley limestone, the Memorial Day Cave project had an inauspicious beginning. The Germany Valley Karst Survey (GVKS), where all motley cavers from in and around the Mid-Atlantic and Northeast U.S., who were long on heart when it came

to digging but short on technology, wanted to crack the Memorial Day Cave. The early days at Memorial Day saw much sledge hammering and slow progress. Eventually air hammers were brought in, but that still was not enough to make the real progress needed for a breakthrough.

Tom Barton arrived on the scene at one dig and showed us how to successfully remove hard limestone. Within hours of our work, we were lunging into booming passage. Over the ensuing project weekends we surveyed hundreds of feet and had a grand time doing it. And just as things would seem to dry up, a new lead would be dug open and the crew would push on. Such was the case when Tom Barton, Rocky Parsons and I dug through breakdown to open up the "Scoop-2" section. Also opening up big sections was the crew of Mike Frisina, his son, and others who dug through the "Chocolate Surprise" to follow air into even more giant passage.

Pushing through small crawlways during the spring and fall of 2002 finally brought the GVKS crew to the top of a canyon which led downstream to the top of a 50 foot pit. I returned with Pete Penczer, Bob Robins and a Texas caver to drop that pit and discover the lead at the bottom that would become known as

the "Puppet Buster." Several trips later, with squeeze freaks and rock shavings, the "Puppet Buster" was penetrated and a 125 foot drop at the far end was bottomed. Then the cave REALLY took off.



The canyon above the "Puppet Buster" would be given a memorialized name during our subsequent trip. Named "Columbia Canyon," in remembrance of the lives lost during the shuttle disaster in February, which occurred just moments before our third trip, our tributes were given to their families that day.

After that trip, and the last report on progress from the cave, the survey stood at 1.6 miles. The survey stopped in a huge chamber, since named the "Pinnacle Room," which is conservatively estimated at 300 feet in length. Leads go off from the room in many directions, including a 10 x 20 high lead 100 feet above the floor.

Since that report, additional surveys have continued to amaze and push the cave. Multiple teams have been fielded during the last few months to extend the many leads branching from the "Pinnacle Room." Miles Drake, Ralph Hartley, Steve Biggers, Rick Royer, Mike Frisina, Pete Penczer and Tom Barton have racked up almost an additional mile of passage over two survey weekends.

The most promising lead went north

east from the "Pinnacle Room" along the strike. From this juncture and through several hundred feet of large paleo trunk passage, the survey walled to the edge of a sketchy 40 foot drop. A return trip would make it down the drop to discover another large room with more going leads. That area of the cave has yet to end.

To the east of the "Pinnacle Room" a large complex of passages wound itself into an X-shaped junction, and the first loop in the cave was finally made. But this area became interesting for more reasons: 1) The highest point in the cave was found there (70 feet above entrance datum) and brought the cave's total depth to 425 feet. 2) The survey of one passage ended at the edge of a spectacular dome pit that extends 40 feet into the ceiling and at least 60 feet down into the floor. A return team will try to bolt a route around the left wall to continuing borehole on the other side, but dropping the pit may also find another way on as well.



Finally, the most recent big discoveries occurred during the incredible flood weekend which wrought so much havoc across West Virginia. Not only was VAR washed out, cavers in Greenbrier nearly blown away, and the pit entrance to Cassel cave collapsed shut, but two survey teams were trapped in Memorial Day as they waited for high water to recede.

The survey crews had entered on Saturday morning to work in the northern reaches of the cave. During their efforts, one group dropped down into a passage that took them into yet another large room, just south of and nearly underneath the

“Pinnacle Room.” As usual, it had numerous leads to survey and as the crew made a round trip to close a loop back in the large room, they noticed one of their stations was now under water.

There was no immediate threat, the cave is huge in volume and they had hundreds of feet of airspace above them. But as they returned to the 125 foot drop below the “Puppet Buster” they found their way blocked by a long, deep lake filling the passage from wall to wall. It would be a long swim to the rope, possibly 100 feet or more, and they couldn't see the rope. Incredibly, Pete Penczer, dared the swim. With the aid of some air-filled water bottles in his cave pack, Pete made it across the lake where he found the rope, was able to ratchet on, and begin ascending, all while treading water in a dangerous situation.

Immediately upon exiting the cave, Pete contacted several people top-side who returned with flotation gear and food. The incredible Brien Farris, already a hero at VAR, dog-

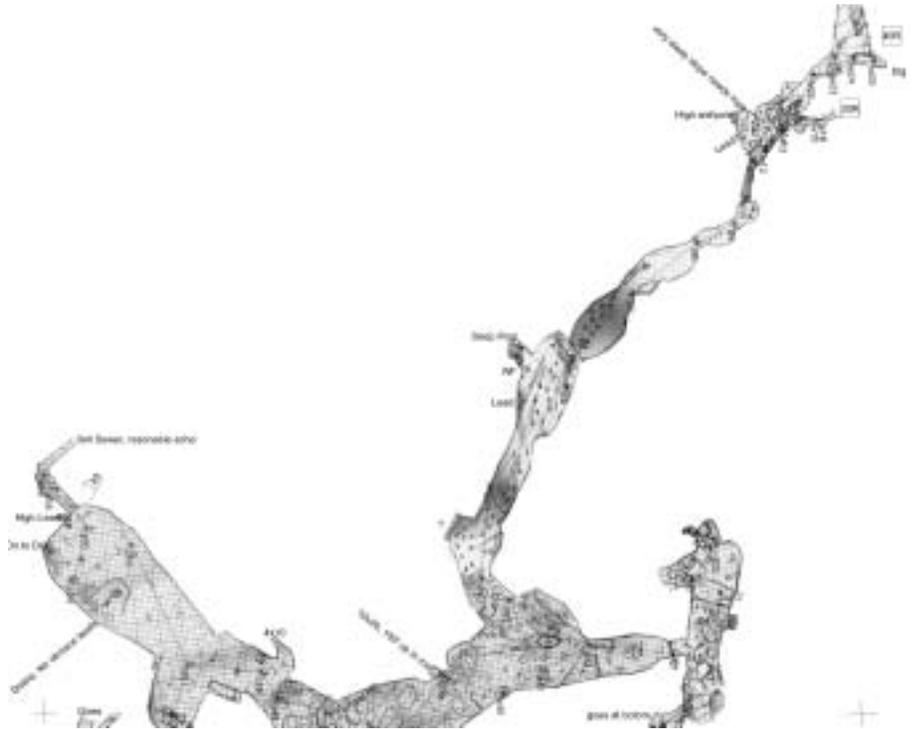


paddled his way to the stranded cavers who gratefully accepted his inflatable raft. All concerned were out of the cave by 7 p.m. Sunday after nearly 36 hours underground.

Meanwhile, the total surveyed cave now stands at 2.5 miles in length. See [Cartos mophed working map on page 23](#).

More information about Memorial Day cave can be found on the web at

[www.psc-cavers.org/memorial](http://www.psc-cavers.org/memorial)



Memorial Day working map that shows the northernmost reaches of the cave, including the Pinnacle Room in the lower left corner.

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Continued from Page 18 to all involved hope I did not leave any one out while writing this.

Dig hard;

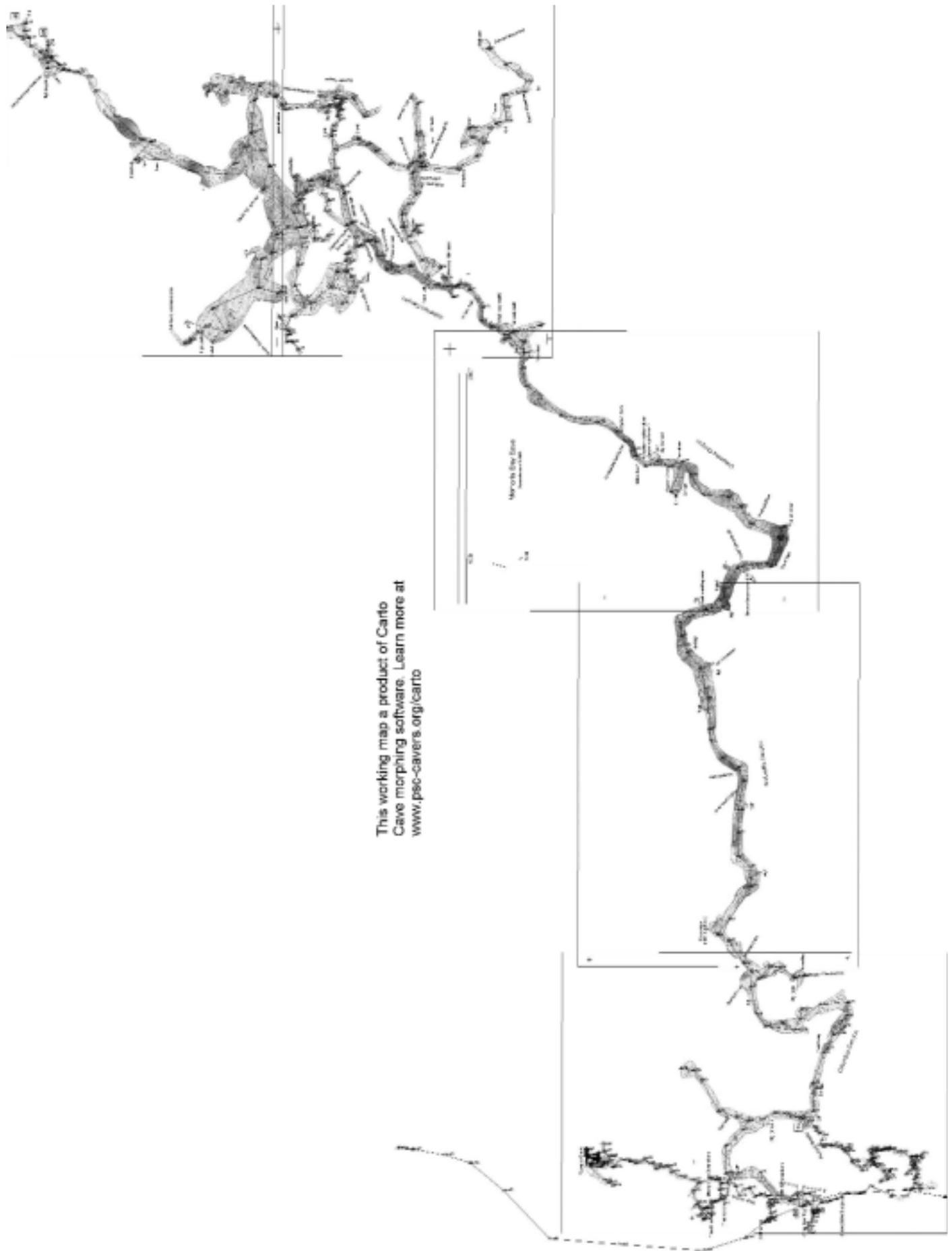
Photo by Glenn Ledbetter

See the Shot in the Wall Map on the back cover.



Glenn Ledbetter at the entrance of his latest find, Shot in the Wall Pit, holding the tool that gave it its name. Photo by Terry Ragon.





This working map a product of Carfo  
Cave morphing software. Learn more at  
[www.psc-cavers.org/carfo](http://www.psc-cavers.org/carfo)

# Shot in the Wall Pit

Jackson County, Alabama

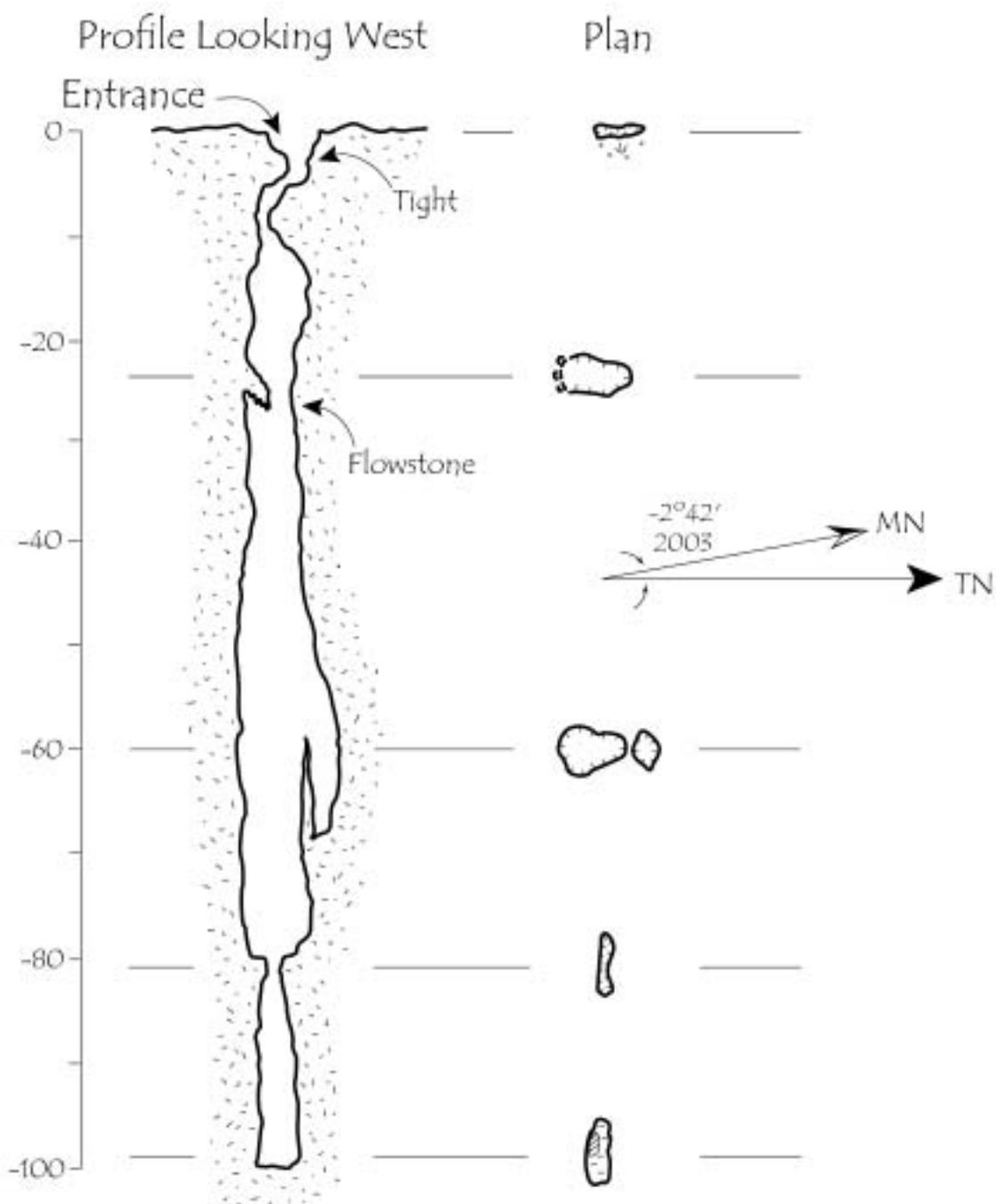
Tape and Compass Survey

on April 25, 2003 by:

Harold Calvert                      Jeff Lynn

Chrissy Frotten                      Terry Ragon

Glenn Ledbetter                      Evon Thompson



## General Notes:

All Measurements in feet. The plan and profile are shown at the same scale. Standard 1976 NSS Symbols used.

The pit is formed in the Bangor Limestone.  
Total Vertical Extent is 100'.